

EARTH RETAINING SYSTEMS

IR 16-3

References: 2001 CBC, Section 1611A.6
2007 CBC, Section 1806A.1

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Discipline: Structural

This Interpretation of Regulation (IR) is intended for use by the Division of the State Architect (DSA) staff, and as a resource for design professionals, to promote more uniform statewide criteria for plan review and construction inspection of projects within the jurisdiction of DSA, which include State of California public elementary and secondary schools (grades K-12), community colleges, and state-owned or state-leased essential services buildings. This IR indicates an acceptable method for achieving compliance with applicable codes and regulations, although other methods proposed by design professionals may be considered by DSA.

This IR is reviewed on a regular basis and is subject to revision at any time. Please check the DSA web site for currently effective IR's. Only IR's listed in the document at <http://www.dsa.dgs.ca.gov/Pubs/default.htm> (click on "DSA Interpretations of Regulations Manual") at the time of plan submittal to DSA are considered applicable.

Purpose: The purpose of this IR is to provide guidelines for use of segmental retaining wall systems. Requirements for segmental retaining walls are not completely addressed in the California Building Code.

1. General. Gravity type retaining walls assembled of precast concrete or concrete masonry units, referred to as Segmental Retaining Walls (SRW), may be approved for use on school building projects as an alternative to conventional retaining systems. Approval of SRW systems requires compliance with the conditions of this IR and approval of the Division of the State Architect (DSA).

SRW systems consist of facing units anchored to a reinforced soil mass that provides gravity load for resistance to overturning and lateral sliding. Geosynthetic grid materials (geogrid) are used to anchor the facing units and to reinforce the soil mass. Only soil-reinforced SRW systems will be acceptable for use on public school, state-owned or state-leased essential services buildings or California Community College projects. The reinforced soil mass may consist of cohesive or cohesionless soil subject to the recommendations of a geotechnical report.

Retaining walls less than four feet above the top of the foundation and not supporting a surcharge do not require review and approval by DSA as defined in Title 24, Part 1, Section 4-314 under the definition of "school buildings." However, such walls should meet the manufacturer's specifications and the applicable design and wall system requirements described below.

2. Geotechnical Requirements. A California licensed geotechnical engineer, in accordance with the 2001 CBC, Section 1804A (2007 CBC, Section 1802A), shall prepare a soil investigation report for each project site. Recommendations for preparation of the reinforced soil mass and slope stability above and below the retaining wall (if necessary) shall be addressed in the report.

3. Design Requirements. Design of the SRW systems shall comply with the National Concrete Masonry Association (NCMA) *Design Manual for Segmental Retaining Walls*, latest edition (based on the Coulomb earth-pressure theory), or the AASHTO *Highway Specifications*, latest edition, (based on the Rankine earth-pressure theory). Seismic analysis will be required for walls greater than 10'-0" above the top of the foundation that support loads from roads, parking areas, etc. or which retain soil adjacent to structures where failure can create a life safety hazard. Structures shall not be supported by SRW systems. Seismic analysis shall be based on

the Mononabe-Okabe theory and shall comply with the NCMA *Segmental Retaining Wall Seismic Design Procedure* (latest edition), or AASHTO *Highway Specifications*. The design shall include the effect of all surcharge loads, potential settlement and sloping soil conditions for both gravity and seismic analyses.

The wall design shall be prepared by a California licensed civil engineer.

Complete design calculations and details of the retaining system shall be submitted to DSA for review and approval with the contract drawings and specifications. Deferred approvals will not be permitted. Design drawings shall include the following information:

1. Locations and elevations of the top and bottom of all wall sections including the foundations.
2. Geogrid type, location and embedment lengths behind the interior face of the block units.
3. Soil gradation requirements, assumed soil design properties and placement/compaction specifications for the reinforced backfill and block unit fill material.
4. Location and size of all holes or openings cut into the geogrid.

4. Wall Height Limitations.

4.1 SRW systems shall be limited to a maximum height of 10'-0" above the top of the foundation and shall have a minimum horizontal clear distance from the back of the block units to the building foundation of 12'-0".

5. Wall System Requirements.

5.1 All SRW block units shall have a mechanical interlocking mechanism between adjacent units, such as formed lips, pins or keys, that will resist horizontal movement out of the plane of the wall. The geogrid shall be mechanically anchored to the block units through the use of aggregate interlock, pins, pipes, etc. Formed lips in block units will not provide adequate anchorage unless configured to mechanically engage the geogrid.

Adequacy of the mechanical interlock must be maintained if separation in block courses due to settlement of the lower course, uplift of the upper course or bulging of the surface between geogrid layers occurs. The design performance objective of SRW's is to limit course separations to 1/4" maximum for the life of the wall.

5.2 Installation of SRW systems shall be in conformance with the manufacturer's instructions and the NCMA *Design Manual for Segmental Retaining Walls* or AASHTO *Highway Specifications* provisions.

5.3 Acceptable geogrid suppliers and grid types shall be identified and their allowable long-term design strength and pullout of grid-to-block values provided.

5.4 Design factors of safety for systems based on NCMA *Design Manual for Segmental Retaining Walls* shall be considered as a "critical application" per Table 5-1. Design factors of safety for systems based on AASHTO *Highway Specifications* shall be equivalent to the NCMA Design Manual for critical application.

5.5 The maximum vertical spacing of the geogrid shall be 2'-8" o.c. An additional layer of geogrid shall be provided in the top 12" of all soil-reinforced walls.

5.6 Drainage pipes and aggregate backfill shall be provided between the facing units and the reinforced soil mass. The backfill shall extend full height and length of the wall at a minimum thickness of 1'-0" and shall meet the compaction requirements specified in the manufacturer's

specifications. Surface drainage at the top and bottom of the wall shall be directed away from the wall.

5.7 In retaining wall systems with corners, the geogrid layers shall be staggered at adjacent walls to avoid overlap of grids and permit planer installation at each level.

6. Testing and Inspection.

6.1 An approved special inspector shall continuously inspect the construction of the wall.

6.2 The reinforced soil mass and granular backfill shall be placed and compacted under the direction of a Geotechnical Engineer (or his representative) as required by the 2001 CBC, Section 1804A.1 (2007 CBC, Section 1802A.1).

6.3 The concrete or concrete masonry mix design and strength evaluation for the precast units shall be in compliance with the CBC, Chapter 19A and 21A. A letter of certification shall be provided with the units indicating the manufacturer's name and address, name of product and unit type. The certification shall include applicable laboratory compressive strength and absorption test results.

6.4 Letters of certification shall be provided for the supplied geogrid indicating the supplier's name and address, name of product and the product designation meeting the requirements of the project's design. The letter of certification shall include the roll numbers and identification procedures, sampling procedures and the results of the quality control tests which include flexural rigidity, tensile strength and modulus and junction strength for each batch of resin and each shift's production used.